

RE2 Optimization of Bioenergy Use, Additional Exercises (2 ECTS)

WILL HAVE TO BE RETURNED BY 3.9.2012 BY EMAIL OR MAIL

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ANSWERS TO ESSAY QUESTIONS MAX. 200 WORDS EACH

1. What are the main benefits for the society due to the increasing use of bioenergy?
2. Discuss the linkages between bioenergy and carbon cycle.
3. What are the socioeconomic impacts of bioenergy use?
4. Give an outline of the expected development of small scale biomass use in EU and its member countries. Elaborate on techniques in use currently and describe potential techniques that could be used.
5. What biomass properties are important for pellet business?
6. Describe detailed chemical reactions and phenomena going on during torrefaction of spruce at 300 °C 30 min. Estimate the final composition.
7. What is difference between thermal treatment, torrefaction and pyrolysis?
8. You have 1000 pellets with length of 30mm and diameter of 8mm. How much more you have reaction surface for ignition if you have 3000 pellets with 10mm length instead? (i.e. total volume and weight of pellet amount are remaining the same. Make theoretical calculation, do not assume microscopic texture of cut surface).
9. Different fuels behave very differently when burned in a fluidized bed. Discuss which fuel properties are important when considering a fuel to be used in a large scale FBC boiler.
10. Calculate the terminal velocity of silica sand particles of 100 μm in air at 25°C and 900°C.
11. Calculate the pressure drop of a fluidized bed reactor with a bed height of 1 m silica sand and air at 25 and 900°C.
12. How does a flue gas cleaning concept for biomass and waste combustion look like?
13. Out of the impurities of in gasification product gas, which are most common for a) coal gasification, b) biomass gasification and c) gasification of solid waste?
14. Natural gas and biogas.
- What are the differences between the two (sources and composition)?

- What are the advantages of natural gas when compared with other fossil fuels?
- What are the pros and cons of biogas, compared with natural gas?
- Explain the terms CNG and LNG.

15. What is the preferred biofuel choice by VOLVO Trucks? Find the answer in the Internet. What are pros and cons of that fuel? Compare the justification with the VTT report 2426.

16. Syngas/product gases after gasification reactor have the properties listed in Tables below. There are two different cases:

- 1) Gasifier using oxygen (oxygen-blown) as gasification reactant gas
- 2) Gasifier using air (air-blown)

	1) Oxygen-blown	1) Oxygen-blown	2) Air-blown	2) Air-blown
Component	Volume-%	Weight-%	Volume-%	Volume-%
CO	24.45	32.94	19.16	21.83
CO ₂	17.80	37.70	11.48	20.55
H ₂	28.06	2.72	14.63	1.20
H ₂ O	22.31	19.34	10.02	7.34
CH ₄	5.91	4.56	4.54	2.97
N ₂	1.21	1.61	40.02	45.61
C ₆ H ₆	0.17	0.63	0.12	0.39
C ₁₀ H ₈	0.08	0.50	0.02	0.11
TOTAL	100	100	100	100

	Lower heating value (LHV)	Higher heating value (HHV)
Component	kJ/g	kJ/g
CO	10.1	10.1
CO ₂	0.0	0.0
H ₂	119.9	141.9
H ₂ O	0.0	0.0
CH ₄	50.0	55.6
N ₂	0.0	0.0
C ₆ H ₆	40.6	42.3
C ₁₀ H ₈	39.4	40.8

a) Assuming that the flowrate of syngas/product gas is 1000 g/s, what is the energy content of the oxygen-blown and air-blown gas mixtures (MW)? If 40 % of this chemical energy is converted to power, what is that amount?

For the calculation of energy content, please use the “LHV” numbers.

b) What are the average heating values (LHV and HHV, in MJ/kg) of these two gas mixtures?

c) What are the main differences of the energy production properties of these two gas mixtures?

d) Considering 1000 g/s of air-blown gasification product gas, what would be the corresponding flowrate (g/s) of biogas with the same energy content? Biogas can be assumed to consist of 95 vol-% CH₄, 4 vol-% CO₂ and the rest is nitrogen (N₂).

17. Calculate how big volume of light fuel oil has the same energy content as 1 stock m³ birch logs. The loose density of birch in stock is 480 kg/m³ in the water content mentioned later. Effective heating value of birch is 18.8 MJ/kg (dry wood) and its water content is 22 wt% in the stock under consideration. Heating value of light fuel oil is 43.2 MJ/kg and its density is 920 kg/m³. The heating values are LHV.

18. a) Calculate the heating value of gasoline E10 (MJ/kg), if it is assumed that it contains 10 volume-% ethanol and 90 volume-% gasoline.

Gasoline: heating value 43 MJ/kg, density 0.75 kg/l.

Ethanol: heating value 26.8 MJ/kg, density 0.789 g/cm³ = 0.789 kg/dm³ = 0.789 kg/l

b) How many kilometers shorter is the driving distance using E10-gasoline (which contains 10 % ethanol) in comparison to using 100 % fossil gasoline? The assumed application is a car which consumes 7 liters/100 km 100 % fossil gasoline and the total volume of liquid fuel is 50 liters.

It is assumed that the efficiency coefficient of the car motor is 30 % and is constant with different liquid fuels (actually for E10 the efficiency coefficient is slightly higher because of the higher octane number of ethanol (110)).

c) How many kilometers shorter is the driving distance using E85 ethanol flexfuel, when it is assumed that the ethanol-content of the fuel is 80 volume-%?